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SELF-REPORTED HEALTH: CROSS-REGIONAL DIFFERENCES IN THE UNITED STATES, 2010

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ABSTRACT

Although self-reported health surveys are used widely by governments, hospitals and companies, there has been little cross-regional investigation of the reliability of these self-reported inventories. I demonstrate the distribution of the self-reported health rate and some factors that may affect the distribution using a National Health Interview Survey (NHIS) sample that focuses on respondent aged between 50 and 85 in year 2010. Then I examine the relationship between self-reported health and real health by constructing disability weights and find that respondents' self-reported health is generally consistent with their real health status, except for west region, suggesting that more future works could be done to study its cause.

ACKNOWLEDGMENTS

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CHAPTER ONE

INTRODUCTION

Self-report inventories like questionnaires and surveys are among the major sources of today's social and behavioral economic studies. However, self-reported health status has some severe limitations and need to be reviewed with extreme attention (Sen, 2002). Respondents may report they health improperly due to race, gender or even emotions. Older respondents tend to report better health than younger ones (Groot, 2000). Cross-country differences in reporting styles and language differences also affect people's attitudes toward their self-report results (Jürges, 2006).

Cross regional study is more suitable where a common language is used (Sil, 2009). This paper examines the self-report differences with respondents' "real health" and self-report style differences across four regions (North, Midwest/ North Central, South and West of the United States) within the United States where English is used as the official language. The first objective regards regional comparison. All the respondents in the survey answered all the questions with English. Thus, I examine whether other major regional differences, other than language, also affect self-report health. To achieve this goal, I compare the coefficient of four (North, Midwest/ North Central, South and West of the United States) simple linear regressions with independent variables such as people's education levels.

As concluded by Jürges (2006), substantial changes take place when differences in reporting styles are taken into consideration. These differences in reporting styles, which are impractical to measure precisely, are both interpersonal and intercultural. For one thing, I assume that different reporting styles are normally distributed within the United States. For another, I use demographic variables such as race and gender, which explain parts of reporting style differences themselves, to estimate their effect on self-reported health.

The second objective is to compare self-report health and real health distributions. I construct the measure of real health by separating the one to five rating system which is used to measure reported health into less subjective “yes” and “No” system (i.e. use people’s reported symptoms to estimate people’s real health) that presents an exclusive disjunction. “Yes” and “No” questions are straight forward for people to answer. They are based on individual rather than expert opinion. These questions can be used to estimate how much worse health people with a certain condition report they are than people without that condition (Cutler, et al. 1997). Accordingly, I build an ordered probit model which includes major conditions and health variables such as BMI (Body Mass Index) to construct disability weights and hence estimate real health status. Then I compared self-report health and real health distributions in four regions across the United States.

CHAPTER TWO

LITERATURE REVIEW

There is substantial amount of research on measurements of people's health status. Also relevant to this paper is previous work examining the relationship between reported health and real health. The existing literatures on different cross-country report styles are reviewed in this chapter.

In 1980, Wolinsky and Zusman mentioned two composite health status measures (one continuous summary measure, one discrete measure) in their paper Toward Comprehensive Health Status that aims to build a standard measure to define health status with data from self-reported survey. They compared their two measures and concluded that measurement error could be reduced by using discrete rather than continuous scaling. Likely, they acknowledged that the prior measure showed much more utility than the latter.

To examine the relationship between reported health and real health empirically, Idler and Benyamini (1997) used three approaches to measure QALY (quality-adjusted year life) weights that can explain real health individually. They also discussed how to solve linearity issues caused by complication and find that five combinations of conditions showed a particularly high joint prevalence. In addition, they analyzed data from the 1989-91 National Health Interview Surveys (NHIS) and noticed that conditions usually considered serious, such as heart disease and stroke, have low coefficient whilst conditions such as vision problems have relatively high coefficients. They found that age difference is very big and could bias the age coefficient when use "age" to interpret report real health. QALY weight is a cost-effective method to explain for people's health changes across time. But according to Stouthard, et al. (2000) the disability weight have been a step forward in quantifying health changes in the public health field. They also addressed two of the remaining issues regarding disability weight: One is the application of the methods and the comparability of the results in a national context, the other concerns the feasibility of the valuation protocol of disability weights. Murray et al., (2000) think response category cut-points are different even across socio-economic groups within a country. Also, they think cut-points may systematically shift over time.

More recent studies suggesting misreporting is widespread in social programs and studies. As noted by Martinelli and Parker (2009), one possible explanation for these is that large program (such as insurance plan) benefits encourage underreporting and discourage over reporting. Jürges (2006) found that different cultures and different languages used in survey result in different reporting styles. Jürges (2006) also found that counterfactual self-reported health distributions that assume identical response style in each country show much less variation in self-reports than factual self-reports. Failing to account for difference in reporting styles, according to Jürges (2006), may yield misleading results. Jürges (2006) use ordered probit model to estimate disability weight. The calculation is based on self-reported health.

As noted in the introduction section, health status is related with individual's education level. Conti, et al. (2010) identified a strong causal effect of education on health. But they also mentioned that health returns on education can vary vastly.

Disability weight is a measure that provides the bridge between mortality and non-fatal outcomes in DALYs and in health life expectancy. Salomont et al. states in their paper *Common values in assessing health outcomes from disease and injury: disability weights measurement study for the Global Burden of Disease Study 2010* (2012) that most of the 220 disability weights they calculated were located on the mild end of the severity scale, with 58 (26%) having weights below 0·05 on the 0 to 1 scale. They demonstrate that is it practicable to measure a wide range of health outcomes in any population. Also, they challenge the prevailing hypothesis that assessment of disability weight should vary across sample with diverse social, educational or demographic circumstances.

A new study (*Establishing disability weights from pairwise comparisons for a US burden of disease study*) conducted in 2013 by Rehm and Frick find that conditional Logistic (CLR) and Probit Regression (PR) converge in yielding stable regression weights to construct disability weights, with a correlation of 0.816 and result in 92.5% identical decisions.

Previous research has ignored the possibility that cross-regional (inside a country) differences result in self-reported health differences. By calculating regional disability weights, this paper allows for regional comparison in detail.

CHAPTER THREE

DATA

The data are drawn from the U.S. National Health Interview Survey (NHIS) for the year 2010. NHIS is the principal source of information on the health of the civilian noninstitutionalized population of the United States and is one of the major data collection programs of the National Center for Health Statistics (NCHS). Since 1957, NHIS has monitored the health of the United States and the content of its survey has been updated about every 10 to 15 years. The main object of NHIS is, as mentioned above, to monitor the health of the United States population through the collection and analysis of data on a broad range of health topics. NHIS is a cross-sectional household interview survey. Accordingly, data are collected through a personal household interview conducted by interviewers employed and trained by the U.S. Bureau of the Census according to procedures specified by the NCHS. The expected NHIS sample size (completed interviews) is approximately 35,000 households, containing about 87,500 persons. The sample I choose to use in this paper contains information on about 26,500 respondents aged 50 and over from four major regions (Northeast, North Central/Midwest, South and West) of the United States. To be specific, these regions are recognized by the Census Bureau (see appendix A).

Table 1 gives a general characterization of the NHIS sample by region, age group, gender and race. Overall sample sizes vary a bit by region. South has the largest sample with about 9,696 observations. West has a slightly smaller sample with 6,506 respondents. North Central/Midwest has 5,644 observations and northeast contains the smallest sample with about 4,628 respondents. About half of the sample is between 50 and 61 years old and 10% are age 80 to 85. Regarding the race group, I use whites and others. The reason I use white instead of, say, Hispanic here is because according to the 2010 United States Census, whites constitute the majority of the U.S. population. In this sample, 76.9% of the respondents are whites. The racial distribution difference between South (72.22% whites) and Midwest (84.20% whites) are substantial. Although NHIS also contains information on respondents younger than 50, the observed decline in self-reported health with age may underestimate the decline in true health. (Jürges, 2006) therefore suggest only discuss about respondents aged 50 and over.

Table1: Sample size, by region, sex and age group (age 50 and over)

		Sex		Age Group			Race group	
Region	Total	Male(%)	Female(%)	50-64(%)	65-79(%)	80+(%)	White%	Others%
Midwest	5644	46.24	53.76	58.71	30.32	10.97	84.60	15.40
Northeast	4628	45.01	54.99	59.51	29.34	11.15	78.80	21.20
South	9696	45.47	54.53	59.88	30.80	9.32	72.22	26.78
West	6506	46.76	53.24	62.70	27.54	9.76	76.65	23.35
Total	26474	45.92	54.08	60.71	29.29	9.99	77.10	22.90

Source: The U.S. National Health Interview Survey (NHIS), 2010

As mentioned in the introduction section, education level is an important factor to consider as well. Since education level data for region West is missing in NHIS, I only present the general effect of education here as a result.

NHIS contains a broad range of different health measures, both of physical and mental health. These include self-reported general health, self-reported diagnosed chronic conditions, diet functional limitations, mental problems, height, weight and detailed information such as usual hours sleep per day.

NHIS includes 5-point scales for self-rated health, ranging from “poor” to “excellent”. For questions regarding health conditions such as “do you have cancer?” the answer is either “Yes” or “No”. NHIS contains continuous variable such as BMI (Body Mass Index). BMI is a human body shape index based on an individual's height and weight. It is used worldwide by researchers and physicians to discuss overweight and underweight problems more objectively. According to the 1995 World Health Organization report and the 1998 National Heart, Lung and Blood Institute guidelines, BMI is classified as the following: <18.5 (“underweight”); 18.5 < 25 (“normal weight”); 25 < 30 (“overweight”); 30 < 35 (“low obesity”); 35 < 40 (“medium obesity”); ≥40 (“extreme obesity”). This standard is complicated and confusing. I therefore integrate “low obesity”, “medium obesity” and “extreme obesity” as “obesity”. The final categories are: Underweight (BMI<18.5), Overweight (25<BMI<30) and Obesity (30<BMI). The remaining range (18.5 to 25) is represented as “normal weight”.

In the present paper, I use 15 different physical conditions and one mental condition (mental problem) as reported by the respondents and BMI (Body Mass Index, derived from self-reported hight and weight). Self- reported diagnosed conditions, according to Jürges (2006), is quasi-objective because they are basically subjective information on factual matters. This kind of self-reports sometimes contain some degrees of measurement error, such as over-reporting and under-reporting. For example, some repondents may regard certain single condition such as cancer as a diesease that cannot be treated, and hence rate themselves in poor health whist some repondents may not want to cover the fact that they have some diesases so that they can lower their monthly insurance fee (some insurance plans have a minimum health standard that only allows people they regarded healthy to enroll in). Below, I will use self-reported diagnosed conditions as independent variables in ordered probit recessions. I admit that measurement error could bias their coefficients upwards or downwards and thus weaken their obejetivety as a meaurement to meaure real health. To further adress this problem, every repondent's life need to be monitored, recorded and reported on a daily basis, which is costly and to some extent inhuman. Therefore, in the present paper, I assume that repondents are honest when reporting their conditions and BMIs.

Table 2:
Descriptive statistics of all variables(2010) N=26,474 (full sample)

Variable	Mean	SD	MIN	MAX
Health (1-5,1=excellent)	2.660	1.127	1	5
Individual characteristics & Health Indicates				
Age(years)	64.774	10.463	50	85
Female(1=female, 0=male)	0.568	0.495	0	1
White(1=white, 0=others)	0.769	0.422	0	1
Education(grade)	13.108	3.2544	1	16
Work hours(per week)	17.661	21.462	0	95
Chronic bronchitis (-1=no,1=yes)	-0.875	0.484	-1	1
Hearing Problem (-1=no,1=yes)	-0.977	0.214	-1	1
Mental Problem (-1=no,1=yes)	-0.998	0 .053	-1	1
Vision Problem (-1=no,1=yes)	-0.951	0.310	-1	1
Fever in the past 2 weeks (-1=no,1=yes)	-0.823	0.568	-1	1
Kidney Problem (-1=no,1=yes)	-0.935	0.354	-1	1
Liver Problem (-1=no,1=yes)	-0.957	0.290	-1	1

Ulcer (-1=no,1=yes)	-0.953	0.302	-1	1
Asthma attack/episode (-1=no,1=yes)	-0.912	0.411	-1	1
Cancer(-1=no,1=yes)	-0.984	0.180	-1	1
Carpal Tunnel Syndrome (-1=no,1=yes)	-0.903	0.430	-1	1
Dermatitis, eczema, or other skin rash (-1=no,1=yes)	-0.790	0.613	-1	1
Diabetes (-1=no,1=yes)	-0.896	0.445	-1	1
Joint Symptoms (-1=no,1=yes)	-0.142	0.990	-1	1
Underweight (0=no,1=yes)	0.018	0.134	0	1
Overweight (0=no,1=yes)	0.362	0.481	0	1
Obesity (0=no,1=yes)	0.304	0.460	0	1

Source: The U.S. National Health Interview Survey (NHIS), 2010

Summary statistices for individual characteristics, conditions and measurements are reported in Table2. Respondents' ages range between 50 and 85. 56.8% of the total respondents are females. 76.9% of them are whites. The 13.108 for education level means that the expected formal education level is higher than high school level (12) but lower than bachelor level (14). Average sleeping hours per day is 7.0596 hours. All the conditions list in here is coded to -1 to 1 scale: -1=no condition, 1=has condition. For BMI variables (underweight, overweight and obesity), the "missing variable" here is normal weight (when underweight=overweight= obesity=0).

Regarding the conditions, Table3 describes them well. Initially there are a lot of people answered "unknown" when they replied to questions regarding these conditions. I recoded these "unknown" into "no" because when recoded in this way, the prevalence precentage is close to the real presentages, accroding to WHO. The most prevalent chronic condition is "Joint symptoms" (24.45%), followed by "Dermatitis, Eczema, or other skin rash" (5.00 %). Fever is also a common condition with prevalence rate of

4.2%. The least prevalent one we see here is “Mental problem” (0.20%), which makes sense because those with serious mental problems were not likely able to participate in a survey. Cross-regional differences in self-reported diagnosed conditions are particularly pronuced for chronic bronchitis (with prevalence of about 3.5% in the west and a prevalence of less than 1.9% in the south) and joint syptoms (with 30.79% in the west and 20.64% in the south)

Table 3 Prevalence of Conditions

	Northeast%	West%	Midwest%	South%	Total%
Chronic bronchitis	2.78	3.43	3.37	1.88	3.18
Hearing Problem	0.98	1.59	1.11	1.04	1.17
Mental Problem	0.20	0.13	0.23	0.20	0.20
Vision Problem	2.54	2.57	2.41	2.38	2.46
Fever	4.02	4.02	4.06	4.68	4.20
Weak/failing kidneys	1.25	1.53	1.75	1.36	3.27
Liver condition	0.78	1.06	0.92	1.12	0.99
Had an ulcer	0.87	1.18	1.08	1.21	1.10
Asthma attack/episode	2.34	2.15	1.96	2.04	2.09
Cancer	0.35	0.34	0.40	0.34	0.36
Carpal tunnel syndrome	1.98	2.74	2.47	1.82	2.28
Dermatitis, Eczema, or other skin rash	5.39	5.26	4.86	4.97	5.00
Diabetes (Now taking insulin)	2.30	2.69	2.89	1.69	2.45
Joint symptoms	21.02	30.79	25.30	20.64	24.45

Source: The U.S. National Health Interview Survey (NHIS), 2010

CHAPTER FOUR

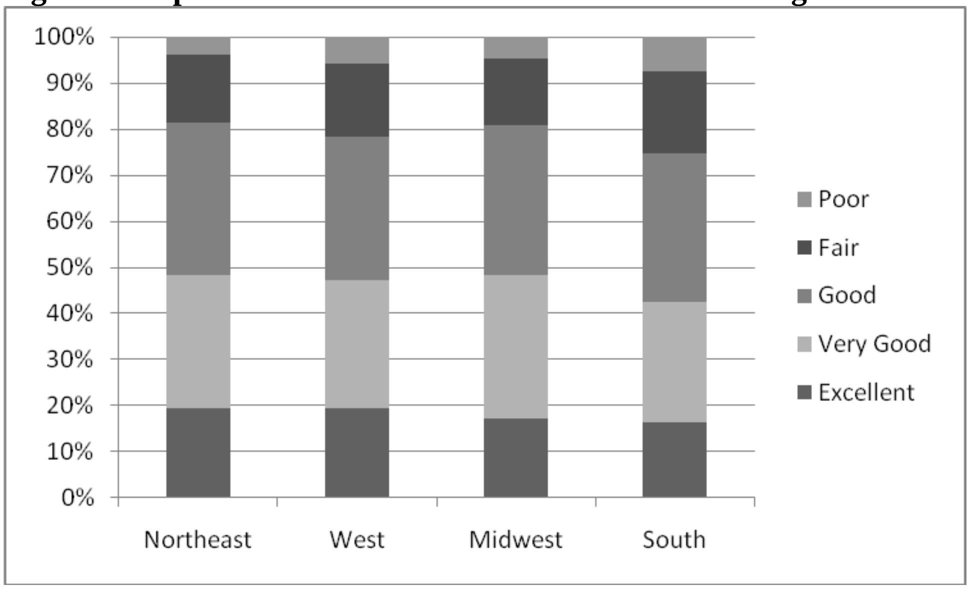
REPORTED HEALTH STATUS DISTRIBUTION AND INFLUENTIAL FACTORS

1. Reported health status distribution

The distributions of self-reported health reflect the overall health status in four regions of the United States to some extent.

Figure 1 clearly presents the distribution of self-reported general health across the four regions. This is the health distribution of individuals aged 50 and over for each region. Regions are ordered by the proportion of respondents who respond that their health status is “excellent”. According to their self-reported health, the healthiest respondents live in the northeast. The least healthy respondents live in the south. These findings are noteworthy: For one thing, about 7.58% of all respondents from the south aged 50 and over respond to be in poor health, whereas the percentage in the Northeast is only 3.91%. For another, in those four regions, the percentages of people respond “Good” health are about one third and are very close to each other (33.21%, 31.22%, 32.28% and 32.35%, respectively).

Figure 1: Reported health distribution in four different regions



Source: The U.S. National Health Interview Survey (NHIS), 2010

Among the 26,474 respondents aged 50 and over, 12,085 of them answered the question "what do you think of your today's health status compared to a year ago?" They can answer "better", "worse" and "about the same". Table 4 shows the breakdown of their health status changes along with the current health status they reported. The majority (8,688) of the respondents respond that their health status is about the same as a year ago. Surprisingly, there is more people (1,935) report better health than people (1,462) report worse health. Also, a small number of people (66) report both poor health and better health whilst some people (46) report both excellent health and worse health. This reflects that these respondents do not regard "poor" as the worst, nor do they regard "excellent" as the perfect status of health.

Table 4: Health status compared to 1 year ago in four regions						
	Excellent	Very Good	Good	Fair	Poor	Total
Better	363	592	625	289	66	1,935
About the same	1,663	2,660	2,841	1,246	278	8,688
Worse	46	147	362	524	383	1,462
Total	2,072	3,399	3,828	2,059	727	12,085

Source: The U.S. National Health Interview Survey (NHIS), 2010

So, is there any regional difference on people's health status compared to a year ago? And how does regional differences affect people's attitude towards their own health? To answer these questions, I run four (for four regions) simple linear regressions taking health status today as the dependent variable and health status compared to a year ago as the explanatory variable. Table 4 shows the result of these regressions. For people aged 50 and over who are living in other parts of the United States, their self-reported health are less likely to be affect by their health change during the past year than those of whom living in the South. In other words, people aged 50 and over who are living in the South tend to have more consistent view about their health change and health status.

Table 5: Regression result of Health on Health change			
	Coef.	Std. Err.	Significant?
Northeast	0.5324154	0.046079	Yes, on 1% level
West	0.4811748	0.037732	Yes, on 1% level
Midwest	0.5040991	0.040093	Yes, on 1% level
South	**0.5771522**	0.03086	Yes, on 1% level

Source: The U.S. National Health Interview Survey (NHIS), 2010

2. Influential factors

The south of the United States contains the highest proportion of respondents who report poor health. This might have something to do about factors such as race. William and Mourey's paper *The concept of race and health status in America* (1994) illustrated that failure to attend to the changes in health indicators within a racial category can prevent the identification of health needs for certain specific groups. It also shows that racial variations in health status result primary from variations among races in exposure or vulnerability to a combination of behavioral and material risk factors rather than merely from genetic factors.

Table 6: Health distributions by region and race

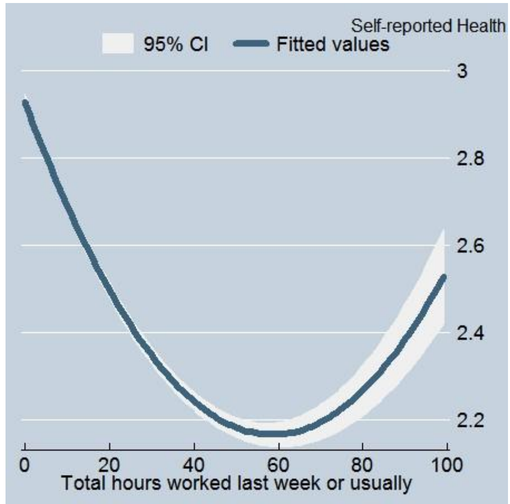
	White	Non-White	Total
Northeast	2.4985	2.7288	2.5473
	78.80%	21.20%	100.00%
Midwest	2.5160	2.9505	2.5829
	84.60%	15.40%	100.00%
South	2.6547	2.9603	2.7396
	72.22%	27.78%	100.00%
West	2.5534	2.7860	2.6077
	76.65%	23.35%	100.00%
Total	2.5696	2.8778	2.6402

1=excellent health, 5=poor health
Source: The U.S. National Health Interview Survey (NHIS), 2010

Since health status is coded from 1 to 5 in table 6 (1=excellent health, 5=poor health), the higher the health reported figure is, the worse average health status the region has. As can be seen from Table 6, overall, non-whites' health status are worse than whites'. To be specific, the worst average health status here belongs to South's non-whites. Meanwhile, we can see that South contains the highest percentage of non-whites (27.78%) with a big self-reported health status gap (2.65 to 2.96) in terms of race. However, the race gap of average reported health status in the North central/Midwest is even bigger (2.52 to 2.95). This is noticeable because the North central/Midwest, in contrast to the South (27.78% non-whites), has the lowest percentage of non-whites (only 15.40% non-whites).

Factors such as age, gender and sleeping hours also exert some effects on people's self-reported health status. From Table A (in appendix D), we can see that age is a significant independent variable that affects self-reported health all over the United States while gender's effect is not significant in regions like Midwest and South. Working hours is an interesting factor to consider here. For people aged 50 and over, many are retired and are not working. Figure 3 clearly shows the relationship between total hours per work and predicted Self-reported health status. One thing worth mention is that it is very likely that the causal relationship is not obvious here. I am not sure whether certain length of working time contributes to certain degrees of health status or whether one's working hour hinges on one's health status. However, we see people in the United States aged 50 and over tends to report best health when work (includes housework) about 60 hours a week. In fact, among the 26474 respondents, 14378 report no work at all. Interestingly, Figure 2 reviews that any amount of work is better than no work at all.

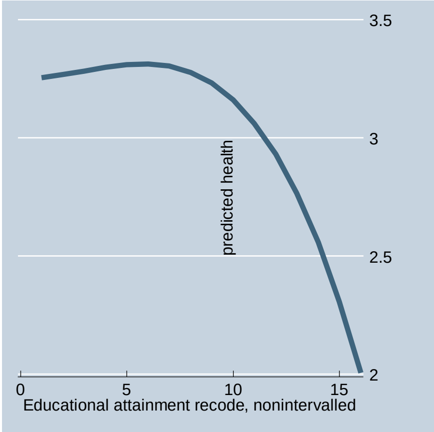
Figure 2: Total hours of work per week and predicted self-reported health status



Source: The U.S. National Health Interview Survey (NHIS), 2010

Education level also affects reported health. Figure 3 shows predict self-reported health in terms of one's education level. On x axis, 0 means no education at all, 1 means the respondents has received grade 1 education only, 2 equals grade 2 …14, nevertheless, has different meaning: 1-3years of college (in other words, drop-outs from college), 15 means with 4 years' college education, 16 means 5 plus years of college. Since health is better (1=excellent, 5=poor) when the figure is smaller, Figure 3 reveals the positive relationship between education level and reported health: the more education one receives, the more likely one will report better health.

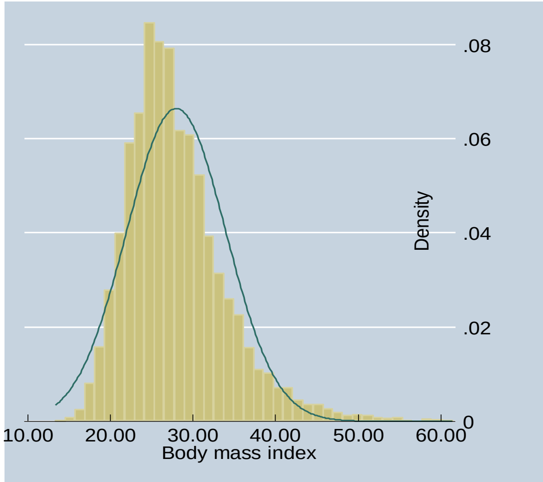
Figure 3: Predict health with educational attainment level



Source: The U.S. National Health Interview Survey (NHIS), 2010

BMI is another important factor that influences reported health. How does it distribute across the United States? And which region has the highest obesity rates? Figure 4 answers the first question. Most of respondents are inside the 18.5 < 25 normal weight range. The right tail, however, is much longer than the left tail. But this is not the case 20 years ago (See appendix 2). This fat tail trend of BMIs is a phenomenon that deserves more attention in future research.

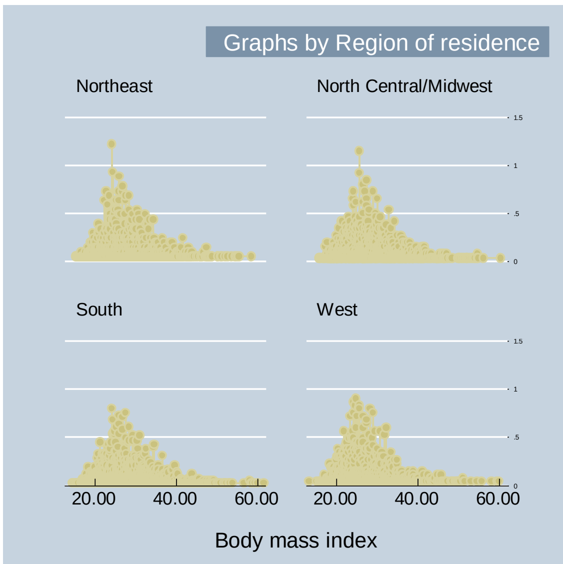
Figure 4: BMI density distribution in the United States



Source: The U.S. National Health Interview Survey (NHIS), 2010

Regarding the second question, I plot the BMI distribution of four different regions in Figure 4. Overall, they have similar patterns: long right tail and close mean. There is no big difference here and there. As a result, BMI may not be a major regional difference to consider when talking about self-reported health.

Figure 5: BMI density distribution in four regions



Source: The U.S. National Health Interview Survey (NHIS), 2010

CHAPTER FIVE

SELF-REPORTED HEALTH VS REAL HEALTH

To compare reported health and “real health”, I need to define what real health is and how to measure it. First of all, “real health” is the exact health status one is in. Second, we cannot measure real health by simply knowing the prevalence rate of certain disease/condition. We also need to know the disability weight for those conditions as well. According to WHO (World Health Organization), disability weight is a weight factor that reveals the severity of a condition on a scale from 0 (perfect health) to 1 (equivalent to death). We can use disability weight to compute real health easily. The formula is as following:

$$\text{Real Health} = 1 - \Sigma\,(\text{condition*disability weight}) \tag{1}$$

I will apply the same econometric model used in Jürges’s paper *True health vs. response styles: exploring cross-country differences in self-reported health* (2006) in this paper. Accordingly, I construct the measure of real health by separating the rating system which is used to measure reported health into a less subjective “yes” and “No” system (i.e. use people’s reported symptoms to estimate people’s real health) that presents an exclusive disjunction. “Yes” and “No” questions are more straight forward for people to answer. There would be less hesitations or misleading. People’s responses are based on individual opinion rather than expert opinion. These more objective “Yes” and “No” questions can be used to estimate how much worse health people with a certain condition report they are than people without that condition (Cutler, et al., 1997).

A remaining question is how to select indicator diseases since it is not feasible or cost-effective to add every disease exists on earth to conduct this research. I selected 14 diseases following the standards indicated by Stouthard, et al. (2000). First, diseases data are available. There are some missing values here and there in the dataset. I recode these missing value into "No" group and the final percentages are consistent with those in the Global Burden of Disease Study 2010. Second, their expected valuations are evenly covered in the total range. Third, they are easy to interpret. Forth, they have "sizeable" public health impact.

Then, I use a standardized zero to one (zero=near death, one= perfectly healthy) health index to describe one's real health status. No condition and normal BMI equals perfect health (real health=1). Any condition will lower the health index by some percentage (or "disability weight").

Disability weight is derived from the disability adjusted life years (DALYs; Murray 1994). The formula to get DALY is as following:

$$\text{DALY}=\text{YLL}+\text{YLD} \tag{2}$$

Where:

YLL= years of life lost due to premature mortality

YLD=years lived with disability, defined in formula (3)

$$\text{YLD}=\text{I}\times\mathbf{DW}\times\text{LD} \tag{3}$$

Where:

YLD= years lived with disability

I= number of incident cases

DW= disability weight

LD= average duration of disability (years)

As can be seen from above, disability weight (DW) is a key element of DALYs. They are many ways to measure disability weight. According to Rehm, Jürgen, and Ulrich Frick (2010), there are two kinds of approaches: Psychometric tradition approach (Revicki and Kaplan 1993) and economic evaluation (Dolan 2000). The method I use in this paper is a psychometric tradition approach that is rating scales and questionnaire based.

According to Jürges (2006), disability weight of each disease and condition is the same as the respective normalized regression parameter. The variable he based on the calculation of disability weights is self-reported health itself. Likewise, I get these disability weights of each condition by “estimating generalized ordered probit regressions of self-reported health on the set of independent health variables” (Jürges, 2006).

Thus, the function I use to calculate disability weight is as following:

Disability weight (DW) = Ordered probit coefficient (4)

One thing should be noticed here is that disability rate should be viewed as the same inside a region while it may vary across regions. Also, there may be some interaction effects caused by multi-conditions. To account for these interaction effects, I select joint symptom here as an independent variable.

Table 7 provides the ordered probit coefficient we need. The first column shows that on average, all parameters except "underweight" in the probit regression are significant at least on 15% significance level. The first column also shows the disability weight. "Underweight" has the highest disability weight, followed by mental problems, diabetes and cancer. Except for fever which has negative disability weight, "overweight" is the variable with the lowest disability weight, followed by carpal tunnel syndrome and dermatitis, eczema, or other skin rash. Also, gender plays a big role here, but this is not the case for age, gender, work hours or educational level as I mentioned in Chapter 4.

The second column shows coefficients or disability weights of the probit regression that investigates the sample from the northeast. "Underweight" and "cancer" in the northeast have significantly higher disability weights than those from the other regions. However, conditions such as dermatitis, eczema, or other skin rash are not significant in the northeast. The situation in the Midwest /north central, however, is a different story: Ulcer has the highest disability weight; underweight and fever are no longer significant. In the south, hearing problem and vision problem has the highest disability weight (0.120&0.119, respectively) among all four regions. Disability weight of chronic bronchitis is the lowest (0.055) in the west. Also in the west, mental problem has surprisingly high disability weight (1.210): this is because only one respondent in the

West reports mental problem. This extreme value will not affect the final result because disability weight is, in essence, an individual measure instead of a general one.

Table 7: Orderd Probit Regressions of Standardized Self-assessed Health on Health Indicators, and Disability Weights

	Ordered Probit/Disability Weight (ALL)	Ordered Probit/Disability Weight (Northeast)	Ordered Probit/Disability Weight (Midwest)	Ordered Probit/Disability Weight(South)	Ordered Probit/Disability Weight (West)
Age	0.002**	-0.001	0.002	0.004**	0.001
	(0.001)	(0.003)	(0.002)	(0.002)	(0.002
Female	-0.08***	-0.046	-0.209***	-0.089***	-0.038
	(0.020)	(0.050)	(0.044)	(0.033)	(0.043)
White	0.358***	0.356***	0.370***	0.347***	0.322***
	(0.024)	(0.060)	(0.060)	(0.036)	(0.049)
Working hours per week	0.014***	0.015***	0.012***	0.014***	0.013***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Educational years	0.010***	0.009***	0.011***	0.010***	0.010**
	(0.002)	(0.003)	(0.004)	(0.003)	(0.004)
Chronic bronchitis	0.211***	0.232***	0.262***	0.177***	0.141***
	(0.022)	(0.054)	(0.045)	(0.0345)	(0.055)
Hearing Problem	0.235*	0.273***	0.160*	0.325***	0.183**
	(0.046)	(0.126)	(0.107)	(0.082)	(0.075)
Mental Problem	0.320*	0.376*	0.320*	0.068	3.311***
	(0.169)	(0.248)	(0.168)	(0.144)	(0.118)
Vision Problem	0.246***	0.299***	0.199***	0.275***	0.240***
	(0.031)	(0.076)	(0.077)	(0.056)	(0.069)
Fever	-0.062***	-0.125***	-0.003	-0.027**	-0.041
	(0.016)	(0.046)	(0.039)	(0.029)	(0.033)
Weak/failing kidneys	0.418***	0.464***	0.317***	0.374***	0.335***
	(0.028)	(0.073)	(0.068)	(0.046)	(0.069)
Liver condition	0.261**	0.321***	0.258***	0.240***	0.255***
	(0.104)	(0.098)	(0.072)	(0.057)	(0.065)
Had an ulcer	0.287***	0.334***	0.350***	0.266***	0.267***
	(0.034)	(0.098)	(0.070)	(0.063)	(0.070)
Asthma attack/episode	0.206***	0.182***	0.229***	0.124***	0.141***
	(0.023)	(0.060)	(0.055)	(0.043)	(0.051)
Cancer	0.641***	0.643***	0.389***	0.293***	0.253**
	(0.176)	(0.062)	(0.136)	(0.084)	(0.140)
Carpal tunnel syndrome	0.096**	0.068	0.025	0.079**	0.049
	(0.063)	(0.062)	(0.050)	(0.038)	(0.053)
Dermatitis, Eczema, or other skin rash	0.056***	0.042	0.088**	0.113***	0.101***
	(0.041)	(0.041)	(0.035)	(0.028)	(0.033)
Diabetes (Now taking insulin)	0.375***	0.43***	0.245***	0.344***	0.333***
	(0.055)	(0.053)	(0.048)	(.036)	(0.048)
Joint symptoms	0.224***	0.237***	0.232***	0.224***	0.193***
	(0.025)	(0.0252)	(0.022)	(0.017)	(0.022)
Underweight (BMI<18.5))	1.051***	1.077***	0.372*	0.491***	0.303***
	(0.089)	(0.198)	(0.202)	(0.151)	(0.165)
Overweight (25<BMI<30)	0.089*	0.060	0.031	0.020	0.098*
	(0.057)	(0.056)	(0.053)	(0.041)	(0.050)
Obese (30<BMI)	0.314***	0.264***	0.369***	0.289***	0.301***
	(0.063)	(0.062)	(0.055)	(0.042)	(0.054)
Oberservations	26474	4628	5644	9696	6506
Ln likelyhood	16144.58	2788.2405	3527.0186	6013.1364	9491.5515
Pseudo R2	0.0977	0.1113	0.1042	0.1026	0.0819

Source: NHIS 2010 ***p<0.01 **p<0.05 *p<0.15

Disability weights=ordered probit coefficents/(highest predicted health level- lowest predicted health level)

To compare real health with reported health, it is better to standardize self-reported health on 0-1 scale as well since real health is standardized. Table 8 is the summarization and ranks of the standardized real health index (see calculation code I used in STATA in appendix C) in four regions across the United States as well as standardized self-reported health index in these regions.

Table 8: Summarization & ranks of the standardized self-reported and real health indices in the United States

	Self-Reported health(Standardized)				Real health(Standardized)				Real health(Standardized) General DW only			
	Obs	Mean	Std. Dev.	Rank	Obs	Mean	Std. Dev.	Rank	Obs	Mean	Std. Dev.	Rank
All	26474	0.590	0.281	-	26474	0.709	0.121	-	26474	0.709	0.111	-
Northeast	4628	0.613	0.269	1	4628	0.696	0.141	2	4628	0.715	0.106	2
Midwest	5644	0.604	0.270	2	5644	0.694	0.135	3	5644	0.709	0.112	3
West	6506	0.598	0.284	3	6506	0.811	0.068	1	6506	0.717	0.106	1
South	9696	0.565	0.288	4	9696	0.683	0.122	4	9696	0.701	0.113	4

Source: The U.S. National Health Interview Survey (NHIS), 2010

I use two kinds of method to compute real health in each region. One is to calculate respondents’ real health by using separate regional disability weight. The other is to calculate by using a generalized disability weight I get in table 7. These results are in table 8 where I notice basically no difference between these two methods in terms of rank. In fact, they present the same ranks. However, the mean real health of west region is as high as 0.811 under the regional DW column, way higher than the 0.717 result I get by using a disability weight.

Table 8 shows that people in the United States tend not to report honestly. However, people living in west tend to underreport their health at lot. To be specific, northeast is the region with the second best average health but respondents from there report the best health among the respondents from other regions. The situation in the west is interesting to notice: respondents come from there have the best expected health but their reported health merely ranks third among all four regions.

Also worth mention here is the standard error difference across four regions. All the four standard errors (0.269, 0.270, 0.284, and 0.288) are very close to each other under the self-reported column. However, the real health of respondents from west region (with the lowest std. err 0.060) by using regional disability weight seems to vary less than those from other three regions.

CHAPTER SIX

CONCLUSION

This paper demonstrates cross-regional differences in self-reported health across the United States. The result shows that factors such as race, educational level, working hours and BMI exert significant effect on self-reported health.

The result also shows that in the United States, different conditions or health variables such as BMI have different effect on people's health in different regions. Also, self-reported health is almost consistent with people's real health status. In west region, nevertheless, respondents tend to under report their health.

One limitation of this paper is that I cannot take every major disease in to consideration due to lack of available data. I suggest future works add more conditions and study the deep reason that causes the inconsistency between self-reported health and real health.

APPENDICES

Appendix A

The four regions discussed in this paper are recognized and classified by the Census Bureau as following:

Northeast: New England Division (Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, and Connecticut) and Middle Atlantic Division (New York, New Jersey, and Pennsylvania);

North Central/Midwest: East North Central Division (Michigan, Ohio, Indiana, Illinois, Wisconsin) and West North Central Division (Minnesota, Iowa, Missouri, North Dakota, South Dakota, Kansas, and Nebraska);

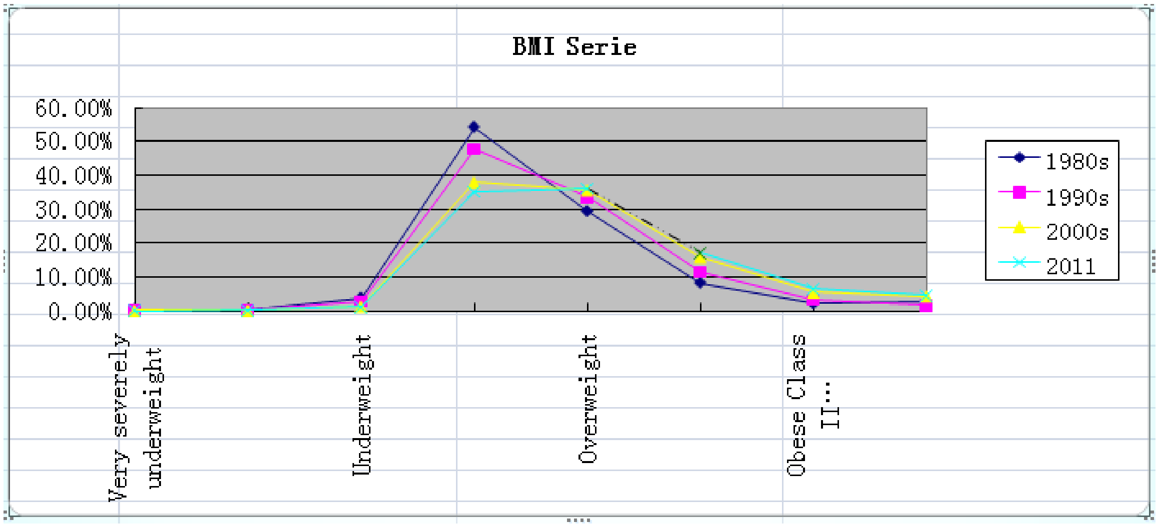
South: South Atlantic Division (Delaware, Maryland, District of Columbia, Virginia, West Virginia, North Carolina, South Carolina, Georgia, and Florida), East South Central Division (Kentucky, Tennessee, Mississippi, and Alabama), and West South Central Division (Texas, Arkansas, Oklahoma, and Louisiana);

West: Pacific Division (Washington, Alaska, Oregon, California, and Hawaii) and Mountain Division (Montana, Idaho, Wyoming, Colorado, New Mexico, Arizona, Utah, and Nevada).

Appendix B

1980s	**Number of observations**	**Percentage**
Very severely underweight	3	0.003
Severely underweight	1673	0.0022
Underweight	27259	0.0363
Normal (healthy weight)	405960	0.5407
Overweight	219619	0.2925
Obese Class I (Moderately obese)	60846	0.081
Obese Class II (Severely obese)	14783	0.0197
Obese Class III (Very severely obese)	8321	0.0246
Total	750786	1
1990s	**Number of observations**	**Percentage**
Very severely underweight	4	6.41915E-06
Severely underweight	1008	0.001617627
Underweight	16982	0.027252522
Normal (healthy weight)	297025	0.47666236
Overweight	208458	0.334531041
Obese Class I (Moderately obese)	70595	0.113290058
Obese Class II (Severely obese)	19485	0.031269308
Obese Class III (Very severely obese)	9578	0.015370666
Total	623135	**1**
2000s	**Number of observations**	**Percentage**
Very severely underweight	1	3.7796E-06
Severely underweight	99	0.000374181
Underweight	3253	0.012295051
Normal (healthy weight)	100177	0.378629364
Overweight	94017	0.355347005
Obese Class I (Moderately obese)	41676	0.157518766
Obese Class II (Severely obese)	14156	0.053504071
Obese Class III (Very severely obese)	11199	0.042327782
Total	264578	**1**
2011s	**Number of observations**	**Percentage**
Very severely underweight	0	0
Severely underweight	2	0.000123472
Underweight	176	0.010865539

Normal (healthy weight)	5672	0.350166687
Overweight	5845	0.360847018
Obese Class I (Moderately obese)	2748	0.169650574
Obese Class II (Severely obese)	1039	0.064143721
Obese Class III (Very severely obese)	716	0.044202988
Total	16198	**1**



Source: The U.S. National Health Interview Survey (NHIS) 1980-2011

Appendix C

```
drop if health>5
gen Northeast= region if  region==1
gen Midwest=region if  region==2
gen South=region if  region==3
gen West=region if  region==4
replace Midwest= Midwest-1
replace South= South-2
replace West= West-3
replace Northeast = 0 if missing(Northeast)
replace Midwest = 0 if missing(Midwest)
replace West = 0 if missing(West)
replace South= 0 if missing(South)
gen male = sex==1
gen female = sex==2
gen underweight = bmi<18.5
gen overweight = bmi<30 & bmi>=25
gen obese = bmi>=30
gen white = racea==100
gen white_male= white*male
gen healthchange= -(hstatyr-2)
drop if healthchange==-7
replace  healthchange=3 if healthchange==0
replace  healthchange=0 if healthchange==-1
replace  healthchange=-1 if healthchange==3
gen post2010 = (year >2010)
replace  cpoxyr=-1 if cpoxyr==2
replace  cpoxyr=1 if cpoxyr!=-1
replace  cronbronyr=-1 if cronbronyr==2
replace  cronbronyr=1 if cronbronyr!=-1
replace  hayfeveryr=-1 if hayfeveryr==2
replace  hayfeveryr=1 if hayfeveryr!=-1
replace  kidneywkyr=-1 if kidneywkyr==2
replace  kidneywkyr=1 if kidneywkyr!=-1
replace  liverconyr=-1 if liverconyr==2
replace  liverconyr=1 if liverconyr!=-1
replace  sinusityr=-1 if sinusityr==2
replace  sinusityr=1 if sinusityr!=-1
replace  ulceryr=-1 if ulceryr==2
replace  ulceryr=1 if ulceryr!=-1
```

```
replace  asthatakyr=-1 if asthatakyr==2
replace  asthatakyr=1 if asthatakyr!=-1
replace  cantreatnow=-1 if cantreatnow==2
replace  cantreatnow=1 if cantreatnow!=-1
replace  ctsyr=-1 if ctsyr==2
replace  ctsyr=1 if ctsyr!=-1
replace  drmyr=-1 if drmyr==2
replace  drmyr=1 if drmyr!=-1
replace  insulin=-1 if insulin==2
replace  insulin=1 if insulin!=-1
replace  jnt3moago=-1 if jnt3moago==2
replace  jnt3moago=1 if jnt3moago!=-1
replace flvision=1 if flvision!=2
replace flvision=-1 if flvision==2
replace  flhear=1 if  flhear!=2
replace  flhear=-1 if  flhear==2
replace  flmental=1 if  flmental!=2
replace  flmental=-1 if  flmental==2
replace hstatyr=4 if hstatyr==3
replace hstatyr=3 if hstatyr==2
replace hstatyr=2 if hstatyr==4
keep if year==2010
keep if age>=50
drop if bmi>90
drop if bmi<1
oprobit health  cronbronyr flhear flmental flvision hayfeveryr kidneywkyr liverconyr ulceryr asthatakyr cantreatnow ctsyr drmyr insulin jnt3moago underweight
overweight obese, robust
oprobit health  cronbronyr flhear flmental flvision hayfeveryr kidneywkyr liverconyr ulceryr asthatakyr cantreatnow ctsyr drmyr insulin jnt3moago underweight
overweight obese if Northeast==1, robust
oprobit health  cronbronyr flhear flmental flvision hayfeveryr kidneywkyr liverconyr ulceryr asthatakyr cantreatnow ctsyr drmyr insulin jnt3moago underweight
overweight obese if Midwest==1, robust
oprobit health  cronbronyr flhear flmental flvision hayfeveryr kidneywkyr liverconyr ulceryr asthatakyr cantreatnow ctsyr drmyr insulin jnt3moago underweight
overweight obese if South==1, robust


preserve
gen health_general=0.2*cronbronyr+0.254*flhear+0.360*flmental+0.283*flvision-0.051*hayfeveryr

+0.368*kidneywkyr+0.255*liverconyr+0.285*ulceryr+0.157*asthatakyr+0.363*cantreatnow+0.051*ctsy

+0.075*drmyr+0.347*insulin+0.214*jnt3moago-0.564*underweight-0.033*overweight-0.292*obese
```

```
su health_general, meanonly
gen nhealth_gen = (health_gen - r(min)) / (r(max) - r(min))
sum health, meanonly
gen rhealth_gen = (health - r(min)) / (r(max) - r(min))
replace rhealth_gen= 1-rhealth_gen
twoway (fpfitci nhealth_gen rhealth_gen, level(99.9))

restore

preserve
drop if South!=1
gen health_south=0.181*cronbronyr+0.332*flhear+0.033*flmental+0.331*flvision-0.060*hayfeveryr

+0.424*kidneywkyr+0.240*liverconyr+0.293*ulceryr+0.118*asthatakyr+0.340*cantreatnow+0.069*ctsy

+0.096*drmyr+0.380*insulin+0.237*jnt3moago-0.533*underweight-0.013*overweight-0.302*obese if South==1
su health_south, meanonly
gen nhealth_south = (health_south - r(min)) / (r(max) - r(min))
sum health, meanonly
gen rhealth_south = (health - r(min)) / (r(max) - r(min))
replace rhealth_south= 1-rhealth_south
twoway (fpfitci nhealth_south rhealth_south, level(99.9))
restore

preserve
drop if Northeast!=1
gen health_northeast=0.232*cronbronyr+0.273*flhear+0.376*flmental+0.299*flvision-0.125*hayfeveryr

+0.464*kidneywkyr+0.321*liverconyr+0.334*ulceryr+0.182*asthatakyr+0.643*cantreatnow+0.068*ctsy

+0.042*drmyr+0.43*insulin+0.237*jnt3moago-1.077*underweight-0.060*overweight-0.264*obese
su health_northeast, meanonly
gen nhealth_northeast = (health_northeast - r(min)) / (r(max) - r(min))
sum health, meanonly
gen rhealth_northeast = (health - r(min)) / (r(max) - r(min))
replace rhealth_northeast= 1-rhealth_northeast
twoway (fpfitci nhealth_northeast rhealth_northeast, level(99.9))
restore
```

```
preserve

drop if Midwest!=1
gen health_midwest=0.250*cronbronyr+0.194*flhear+0.360*flmental+0.270*flvision-0.020*hayfeveryr

+0.378*kidneywkyr+0.316*liverconyr+0.392*ulceryr+0.230*asthatakyr+0.325*cantreatnow+0.050*ctsy

+0.073*drmyr+0.293*insulin+0.216*jnt3moago-0.040*underweight-0.043*overweight-0.349*obese
su health_midwest, meanonly
gen nhealth_midwest = (health_midwest - r(min)) / (r(max) - r(min))
sum health, meanonly
gen rhealth_midwest = (health - r(min)) / (r(max) - r(min))
replace rhealth_midwest= 1-rhealth_midwest
twoway (fpfitci nhealth_midwest rhealth_midwest, level(99.9))

restore

preserve

drop if West!=1
gen health_west=0.147*cronbronyr+0.222*flhear+3.248*flmental+0.272*flvision-0.033*hayfeveryr

+0.307*kidneywkyr+0.278*liverconyr+0.251*ulceryr+0.161*asthatakyr+0.320*cantreatnow+0.019*ctsy

+0.095*drmyr+0.337*insulin+0.191*jnt3moago+0.396*underweight+0.044*overweight+0.261*obese if West==1
su health_west, meanonly
gen nhealth_west = (health_west - r(min)) / (r(max) - r(min))
sum health, meanonly
gen rhealth_west = (health - r(min)) / (r(max) - r(min))
replace rhealth_west= 1-rhealth_west
twoway (fpfitci nhealth_west rhealth_west, level(99.9))

restore
```

Appendix D

Table A: OLS regression of self-reported health status w.r.t.2010

	Northeast	Midwest	South	West	Total
Age	0.0209***	0.011***	0.0162***	0.0177***	0.016202***
	(0.0015)	(0.0014)	(0.0012)	(0.0014)	(0.0007)
Female	0.0748**	0.0072	0.0166	0.117***	0.0497523***
	(0.0312)	(0.0287)	(0.0013)	(0.0279)	(0.0137)
Sleeping hours	0.0050***	0.0037***	0.0034***	0.0032*	0.0036827***
	(0.0016)	(0.0014)	(0.0013)	(0.0019)	(0.0008)
Constant	1.154***	1.848***	1.688***	1.414***	1.571616***
	(0.0948)	(0.0871)	(0.07499)	(0.0892)	(0.0431)

Standard errors in parentheses. Asterisks represent signiėcance: * = 10% level, ** = 5% level, *** = 1% level.

Source: NHIS, 2010

References:

1. Jürges, Hendrik. "True health vs response styles: exploring cross - country differences in self - reported health." *Health economics* 16.2 (2007): 163-178.

2. Cutler, David M., Elizabeth Richardson, and T. Keeler. "Measuring the health of the US population." *Brookings Papers on economic activity: Microeconomics*1997 (1997): 217-271.

3. Stouthard, Marlies EA, Marie-Louise Essink-Bot, and Gouke J. Bonsel. "Disability weights for diseases: A modified protocol and results for a Western European region." *The European Journal of Public Health* 10.1 (2000): 24-30.

4. Wolinsky, Fredric D., and Marty E. Zusman. "Toward Comprehensive Health Status Measures*." *The Sociological Quarterly* 21.4 (1980): 607-622.

5. Rehm, Jürgen, and Ulrich Frick. "Establishing disability weights from pairwise comparisons for a US burden of disease study." *International journal of methods in psychiatric research* 22.2 (2013): 144-154.

6. Idler, Ellen L., and Yael Benyamini. "Self-rated health and mortality: a review of twenty-seven community studies." *Journal of health and social behavior* (1997): 21-37.

7. Benyamini, Yael, and Ellen L. Idler. "Community studies reporting association between self-rated health and mortality additional studies, 1995 to 1998."*Research on Aging* 21.3 (1999): 392-401.

8. Conti, Gabriella, James Heckman, and Sergio Urzua. "The education-health gradient." *The American Economic Review* (2010): 234-238.

9. Williams, David R., Risa Lavizzo-Mourey, and Rueben C. Warren. "The concept of race and health status in America." *Public Health Reports* 109.1 (1994): 26.

10. Martinelli, César, and Susan Wendy Parker. "Deception and misreporting in a social program." *Journal of the European Economic Association* 7.4 (2009): 886-908.

11. Sen, Amartya. "Health: perception versus observation: Self reported morbidity has severe limitations and can be extremely misleading." *BMJ: British Medical Journal* 324.7342 (2002): 860.

12. Williams, David R., Risa Lavizzo-Mourey, and Rueben C. Warren. "The concept of race and health status in America." *Public Health Reports* 109.1 (1994): 26.

13. World Health Organization, ed. *The world health report 1995: bridging the gaps*

. World Health Organization, 1995.

14. Adams, Patricia E., et al. "Summary health statistics for the US population: National Health Interview Survey, 2010." *Vital and health statistics. Series 10, Data from the National Health Survey* 251 (2011): 1-117.

15. Rehm, Jürgen, and Ulrich Frick. "Valuation of health states in the US study to establish disability weights: lessons from the literature." *International journal of methods in psychiatric research* 19.1 (2010): 18-33.

16. Murray, Christopher JL, and Arnab K. Acharya. "Understanding DALYs."*Journal of health economics* 16.6 (1997): 703-730.

17. Revicki, Dennis A., and Robert M. Kaplan. "Relationship between psychometric and utility-based approaches to the measurement of health-related quality of life." Quality of Life

Research 2.6 (1993): 477-487.

18. Dolan, Paul. "The measurement of health-related quality of life for use in resource allocation decisions in health care." *Handbook of health economics* 1 (2000): 1723-1760.

19. Murray, C. J. L., et al. "Enhancing cross-population comparability of survey results." *Global Programme on Evidence for Health Policy Series* 35 (2000).